

CLAIMS

1. A random copolymer based on non-conjugated cyclic polyene comprising structural units originated from one or more α -olefins (A1) and originated from one or more non-conjugated cyclic polyenes (A2), the said random copolymer having characteristic features comprising

a content of the structural unit(s) originated from the said one or more α -olefins (A1) in the range of 93 to 70 mole %,

a content of the structural unit originated from the said one or more non-conjugated cyclic polyenes (A2) in the range of 7 to 30 mole %,

an intrinsic viscosity $[\eta]$, determined in decalin at 135 °C, in the range of 0.01 to 20 dl/g,

a glass transition temperature (Tg) of not higher than 40 °C and

an iodine value in the range of 50 to 150.

2. A random copolymer based on non-conjugated cyclic polyene comprising structural units originated from one or more α -olefins (A1), originated from one or more non-conjugated cyclic polyenes (A2) and originated from one or more non-conjugated linear polyenes (A3), the said random copolymer having characteristic features comprising

a content of the structural unit(s) originated from the said one or more α -olefins (A1) in the range of 97.9 to 55 mole %,

a content of the structural unit originated

from the said one or more non-conjugated cyclic polyenes (A2) in the range of 2 to 30 mole %,

a content of the structural unit originated from the said one or more non-conjugated linear polyenes (A3) in the range from 0.1 to 15 mole %,

an intrinsic viscosity $[\eta]$, determined in decalin at 135 °C, in the range of 0.01 to 20 dl/g,

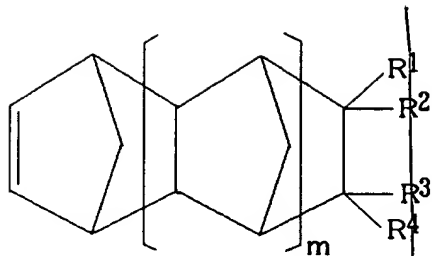
a glass transition temperature (T_g) of not higher than 40 °C and

an iodine value in the range of 5 to 150.

3. The random copolymer as claimed in claim 1 or 2, wherein the structural unit(s) originated from one or more α -olefins (A1) comprise at least a structural unit originated from ethylene in which the mole ratio of (the structural unit originated from ethylene) versus (the structural unit(s) originated from other α -olefin(s) having 3 or more carbon atoms) is in the range from 100/0 to 1/99.

4. The random copolymer as claimed in claim 1 or 2, wherein the structural unit(s) originated from one or more α -olefins (A1) comprise at least a structural unit originated from ethylene in which the mole ratio of (the structural unit originated from ethylene) versus (the structural unit(s) originated from other α -olefin(s) having 3 or more carbon atoms) is in the range from 100/0 to 50/50.

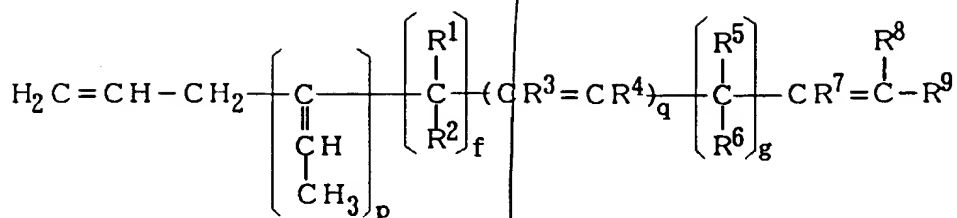
5. The random copolymer as claimed in any one of claims 1 to 4, wherein the non-conjugated cyclic polyene (A2) is that represented by the formula (1-1) given below:



.... (1-1)

in which m is an integer of 0 to 2, R^1 to R^4 denote each, independently of each other, an atom or a residue selected from the group consisting of hydrogen atom, halogen atoms and hydrocarbon residues which may have double bond, wherein R^1 to R^4 may be fused together to form a mono- or polycyclic ring which may have double bond or wherein an alkyldiene radical may be formed from the pair of R^1 and R^2 or R^3 and R^4 or, further, R^1 and R^3 or R^2 and R^4 may be fused together so as to form a double bond, with the proviso that at least one of R^1 to R^4 stands for an unsaturated hydrocarbon residue having at least one double bond, in case the mono- or polycyclic ring formed from R^1 to R^4 by being fused together has no double bond, in case the pair of R^1 and R^2 or R^3 and R^4 does not form an alkyldiene radical and in case R^1 and R^3 or R^2 and R^4 are not fused together to form an endocyclic double bond.

6. The random copolymer as claimed in any one of claims 2 to 5, wherein the non-conjugated linear polyene (A3) is represented by the formula (2-1) given below:



....(2-1)

in which p and q is zero or 1 with the proviso that p and q are not zero simultaneously, f is an integer of zero to 5 with the proviso that f is not zero when both p and q are 1, g is an integer of 1 to 6, R¹, R², R³, R⁴, R⁵, R⁶ and R⁷ denote each, independently of each other, hydrogen atom or an alkyl group having 1 - 3 carbon atoms, R⁸ denotes an alkyl group having 1 - 3 carbon atoms and R⁹ denotes hydrogen atom, an alkyl group having 1 - 3 carbon atoms or a group represented by $-(\text{CH}_2)_n-\text{CR}^{10}=\text{C}(\text{R}^{11})\text{R}^{12}$ in which n is an integer of 1 to 5, R¹⁰ and R¹¹ represent each, independently of each other, hydrogen atom or an alkyl group having 1 - 3 carbon atoms and R¹² represents an alkyl group having 1 - 3 carbon atoms, with the proviso that R⁹ is hydrogen atom or an alkyl group having 1 - 3 carbon atoms when both p and q are 1.

7/. A rubber composition comprising

- (A) a random copolymer based on non-conjugated cyclic polyene comprising structural units originated from one or more α -olefins (A1) and originated from one or more non-conjugated cyclic polyene (A2), the said random copolymer having characteristic features comprising a content of the structural unit(s) originated

from the said one or more α -olefins (A1) in the range of 93 to 70 mole %; a content of the structural unit originated from the said one or more non-conjugated cyclic polyenes (A2) in the range of 7 to 30 mole %; an intrinsic viscosity $[\eta]$, determined in decalin at 135 °C, in the range of 0.01 to 20 dl/g; a glass transition temperature (Tg) of not higher than 40 °C; and an iodine value in the range of 50 to 150, and

(B) a rubber based on diene,

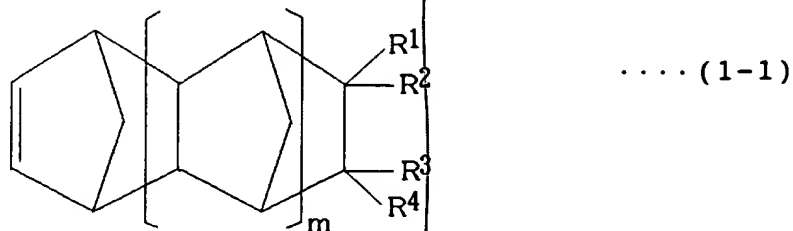
wherein the weight proportion of (the random copolymer based on non-conjugated cyclic polyene) versus (the rubber based on diene), namely, (A)/(B), is in the range of 60/40 to 0.1/99.9.

8. A rubber composition comprising

(A) a random copolymer based on non-conjugated cyclic polyene comprising structural units originated from one or more α -olefins (A1) and originated from one or more non-conjugated cyclic polyenes (A2) and originated from one or more non-conjugated linear polyene (A3), the said random copolymer having characteristic features comprising

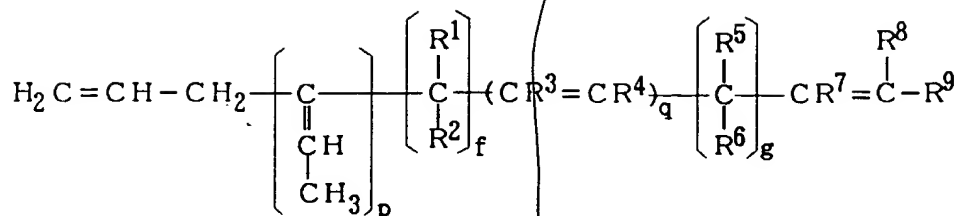
a content of the structural unit(s) originated from the said one or more α -olefins (A1) in the range of 97.9 to 55 mole %; a content of the structural unit originated from the said one or more non-conjugated cyclic polyenes (A2) in the range of 2 to 30 mole %; a content of the structural unit originated from the said

11. The rubber composition as claimed in any one of claims 7 to 10, wherein the non-conjugated cyclic polyene (A2) is that represented by the formula (1-1).



in which m is an integer of 0 to 2, R^1 to R^4 denote each, independently of each other, an atom or a residue selected from the group consisting of hydrogen atom, halogen atoms and hydrocarbon residues which may have double bond, wherein R^1 to R^4 may be fused together to form a mono- or polycyclic ring which may have double bond or wherein an alkylidene radical may be formed from the pair of R^1 and R^2 or R^3 and R^4 or, further, R^1 and R^3 or R^2 and R^4 may be fused together so as to form a double bond, with the proviso that at least one of R^1 to R^4 stands for an unsaturated hydrocarbon residue having at least one double bond, in case the mono- or polycyclic ring formed from R^1 to R^4 by bring fused together has no double bond, in case the pair of R^1 and R^2 or R^3 and R^4 does not form an alkylidene radical and in case R^1 and R^3 or R^2 and R^4 are not fused together to form an endocyclic double bond.

12. The rubber composition as claimed in any one of claims 8 to 11, wherein the non-conjugated linear polyene (A3) is that represented by the formula (2-1).



.....(2-1)

in which p and q is zero or 1 with the proviso that p and q are not zero simultaneously, f is an integer of zero to 5 with the proviso that f is not zero when both p and q are 1, g is an integer of 1 to 6, R¹, R², R³, R⁴, R⁵, R⁶ and R⁷ denote each, independently of each other, hydrogen atom or an alkyl group having 1 - 3 carbon atoms, R⁸ denotes an alkyl group having 1 - 3 carbon atoms and R⁹ denotes hydrogen atom, an alkyl group having 1 - 3 carbon atoms or a group represented by $-(\text{CH}_2)_n-\text{CR}^{10}=\text{C}(\text{R}^{11})\text{R}^{12}$ in which n is an integer of 1 to 5, R¹⁰ and R¹¹ represent each, independently of each other, hydrogen atom or an alkyl group having 1 - 3 carbon atoms and R¹² represents an alkyl group having 1 - 3 carbon atoms, with the proviso that R⁹ is hydrogen atom or an alkyl group having 1 - 3 carbon atoms when both p and q are 1.

13. A rubber material for tires, comprising the random copolymer based on non-conjugated cyclic polyene as claimed in any one of claims 1 to 6.

14. A rubber material for tires, comprising the rubber composition as claimed in any one of claims 7 to 12.

15. A tire tread produced from the rubber material for tires as claimed in claim 13 or 14.

16. A tire which has a ~~tire~~ tread as claimed in claim 15.

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